GENERAL NOTES.

The Work of the Harvard College Observatory.—From Professor E. C. PICKERING'S report for the year ending September 30, 1906, it appears that the work of the Harvard College Observatory continues to be mainly the quantitative and qualitative analyses by visual and photographic methods of the light of the stars. By means of photometers attached to the east equatorial at Cambridge, and of the meridian photometers at Cambridge and at Arequipa, many thousands of measures have been made during the year of the brightness of stars, with the object (*a*) of extending to stars of the thirteenth magnitude the plan of furnishing standards of magnitude on a uniform scale well distributed over the entire sky, and (*b*) of increasing our knowledge of the variable stars, especially of those of long period and of those of the *Algol* type. Miscellaneous photometric measures include the photometric measures of twenty-nine eclipses of *Jupiter's* satellites.

A large number of photographs, including spectrum plates, have been taken with the 11-inch and 8-inch Draper telescopes at Cambridge, and with the 8-inch Bache, the 13-inch Boyden, and the 24-inch Bruce telescope at Arequipa. The study of these plates has already revealed many new variable stars, stars with bright hydrogen lines, etc. Other plates have been utilized to extend the classification of stellar spectra to fainter stars on the plan of the classification given in volume XXVIII of the *Annals*. The great majority of the plates are necessarily stored for future study.

Professor PICKERING again calls attention to the urgent need of the observatory of suitable fireproof buildings for housing the admirable library of the observatory, one of the finest astronomical libraries in the world, for the photographic laboratory, and for a workshop. A still greater desideratum is an addition to the staff of assistants. As Professor PICKERING says, "Perhaps the greatest return could be obtained by the employment of more assistants for the study of the unique collection of astronomical photographs. This collection now contains 189,200 photographs of the stars, and is like a library of that size with only about twenty readers."

An Interesting Variable.—The leading article in the *Astronomische Nachrichten,* No. 4148, by G. MÜLLER and P. KEMPF, gives the determination of the period and the light-curve of a new short-period variable of the *δ Cephei* type. The star is located in the constellation *Cassiopeia,* B. D. 68° 200, and has an average brightness of a little less than the sixth magnitude. Its period was found to be 1.9498 days. But the chief interest lies in the smallness of the range of brightness; this was found to be only 0.33 of a magnitude. Observations were made photometrically by both of the authors, and in order to be certain that the variations found were in reality not large accidental errors of observation they requested a third observer, Mr. K. GRAFF, of Hamburg, to make visual observations upon the star by ARGELANDER'S method, without, however, giving him any exact knowledge of the period to be expected. The observations of Mr. GRAFF completely confirmed those obtained at Potsdam, and there seems to be no doubt about the reality of the variation. When it becomes possible to differentiate with certainty a variation of a quarter of a magnitude from the accidental errors of observation, it serves to illustrate the degree of precision attainable in modern photometric work.

An Unknown Comet.—During 1905 Professor E. E. BARNARD, of the Yerkes Observatory, was stationed for a time at the Solar Observatory of the Carnegie Institution on Mt. Wilson, in California, engaged in photographing the southern portions of the Milky Way with the Bruce photographic telescope of the Yerkes Observatory. After returning from the expedition a re-examination of the plates disclosed the trail of a very faint comet on each of three plates taken on July 22, 1905. These plates have been measured by Professor BARNARD, giving an accurate position of the object, and the results have been published in the *Astronomische Nachrichten,* No. 4153. The comet had a right ascension of between eighteen and nineteen hours and a declination between 20° and 21° south. So far as known, it was neither seen visually by any one nor photographed at any other place. The chief interest in the object lies in the possibility of its belonging to the class of periodic comets. If such should be the case, and it should be observed at some future return to the neighborhood of the

Earth, the position determined by Mr. BARNARD might prove very valuable in fixing its orbit.

Heights of Meteors.—Under the title, "Heights of Large Meteors Observed in 1906," (*Astronomische Nachrichten,* No. 4152,) W. F. DENNING gives some interesting results obtained from the observations of ten meteors in England by himself and persons co-operating with him. The height at appearance varies between fifty-nine and eighty-nine miles, with an average value of seventy miles; the height at disappearance varies between twenty-two and fifty-six miles, with an average value of forty miles; the length of path varies between twenty-four and seventy-two miles, with an average of forty-four miles; the velocity in miles per second (given for only six) varies between fifteen and thirty, with an average value of twenty-two. It would be interesting if some one could devise a means of computing, or even roughly estimating, the mass which must be possessed by a meteor in order that it may give forth light during its flight through a certain stretch of the upper atmosphere at a given velocity.

Isaac Roberts's Celestial Photographs.—Mrs. DOROTHEA ISAAC-ROBERTS has published in the *Astronomische Nachrichten,* No. 4154, a "Preliminary Catalogue of ISAAC ROBERTS'S Collection of Photographs of Celestial Objects." This collection consists of 2,485 original negatives of stars, star-clusters, nebulæ, and other celestial objects, together with many positives on glass and on paper. Over half of the negatives were taken with a 20-inch reflector of ninety-eight inches focal length, and the balance were taken with various lenses up to five inches in diameter.

Mrs. ROBERTS proposes to make this fine collection of negatives available for the advancement of astronomical science, as may be seen from the following quotation from her article:—

"As soon as circumstances permit, a complete list of ISAAC ROBERTS'S tribute to astronomy will be published, in accordance with the wishes and instructions of the deceased.

"The number of copies of the forthcoming paper being very limited, the observatories and astronomers, official or amateur, who are specially interested in photographic astronomy will please send in their names to the address given below, early in 1907, in order that

the various parts of the complete catalogue may be sent to them in course of time.

"Positives-on-glass reproduced from the Isaac Roberts negatives will be lent for the purpose of micrometric measurements, if application be made, and provided that the documents be returned after completion of the measurements."

Mrs. ROBERTS'S address is Château Rosa Bonheur, By-Thomery, Seine et Marne, France.

New Asteroids.—The number of asteroids now exceeds six hundred. Dr. J. BAUSCHINGER, Director des Astronomisches Rechen-Institut, Berlin, has recently printed, in the *Astronomische Nachrichten,* No. 4156, sets of elements for twenty-five of these small bodies discovered during 1905 and 1906.

The *Monthly Notices* of the Royal Astronomical Society for December, 1906, contains an article by Professor H. H. TURNER, "On the Possibility of Improving the Places of Reference-Stars for the Astrographic Catalogue from the Photographic Measures," which is characterized by the simplicity of method and evident practical value which mark his other contributions on the subject of photographic measures. In the process of the reduction of the measured rectangular co-ordinates of star-images on a photographic plate to the right ascension and declination of the corresponding stars, plate constants are derived with the help of the images of stars whose positions are known from meridian or other independent observations. The unavoidable errors in the positions of these stars of reference affect the plate constants and through them the positions of the previously unknown stars which result from the measures. It is the readjustment of the assumed co-ordinates of the stars of reference by a comparison of the measures of their images made on overlapping plates that is treated in this paper.

In the Oxford reductions for the astrographic catalogue it has been customary to substitute for the least-square solution of the equations for the plate constants a method in which all the equations are combined to form eight derived ones, four of which involve the constants *a, b, c,* and the remaining four the constants *d, e, f.* The four derived equations of each group are obtained by adding the equations arising from the

star-images in the four quadrants of the plate respectively. Each of the four derived equations of one group may be regarded as arising from a single fictitious star, its weight being equal to the number of stars in its quadrant. Mr. TURNER shows that if the four equations are of equal weight, and if the four fictitious stars are in the center of their respective quadrants, the four residuals after solution, either by his method or by the method of least squares, are + I, — I, + I, — I, respectively, where I is the algebraic sum of the absolute terms of the four equations, two of them taken with the opposite sign. This quantity I is called the "inconsistency" for the plate. It will be zero in the assumed case if the co-ordinates of the comparison-stars are correct, and the measures are affected by no errors that are not linear functions of the measured co-ordinates. Where the actual state of affairs is not too unsymmetrical it is possible therefore to write down the residuals before the solution is made and to determine, without a solution of the equations, how the residuals would be affected by arbitrary changes in the co-ordinates of the comparison-stars,—that is, in the absolute terms of the equations of condition. It would be entirely possible to make the inconsistency for a single plate zero without improving the plate constants, but any changes that materially reduce the inconsistencies of a series of overlapping plates would undoubtedly improve the plate constants of all of them.

Professor TURNER has not arrived at any general and entirely satisfactory method of accomplishing this adjustment, but the tabulation of the inconsistencies of a series of overlapping plates in "diagrammatic" form will undoubtedly lead to such adjustments, provided the symmetry of arrangement of the comparison-stars is sufficient to render applicable his theorem regarding the residuals.

The Gold Medal of the Royal Astronomical Society Awarded to Professor E. W. Brown.—The gold medal of the Royal Astronomical Society has this year been awarded to Professor ERNEST WILLIAM BROWN for his "Researches in the Lunar Theory."

On presenting the medal to Professor BROWN at the annual meeting of the society, February 8, 1907, the president, Mr. WILLIAM H. MAW, reviewed the work of the distinguished

medalist in an able and comprehensive address, from which the following is taken.

Professor BROWN is the seventh astronomer to whom the gold medal of the Royal Astronomical Society has been awarded for work in connection with the lunar theory.

In a paper entitled "Theory of the Motion of the Moon, Containing a New Calculation of the Expressions for the Co-ordinates for the Moon in Terms of the Time," published in volume LIII of the *Memoirs,* he has clearly stated the nature of the problem on which he has been engaged, in the following words:—

"The formation of numerical expressions deduced as a consequence of the Newtonian laws of motion and gravitation which shall represent the position of the Moon at any time may be roughly divided into three stages. As a first step, we consider each of the three bodies—the Sun, the Earth, and the Moon—as a sphere of mass equal to its actual mass, and arranged in concentric layers of equal density. The Earth (or center of mass of the Earth and Moon) is supposed to move round the Sun in a certain ideal elliptic orbit, and all disturbances of this orbit and of the Moon from any other source than the ideal Sun and Earth are neglected. The first stage constitutes nearly the whole of the problem of three bodies as far as the particular configuration of the Sun-Earth-Moon system is concerned. When this is done, we proceed to the second step, which involves the determination of the effects due to the difference between the actual and the ideal motions of the Earth and Sun, to the influence exercised by the other bodies of the solar system, and to the differences between the real and ideal arrangements of the masses of the bodies. The calculations so far may, theoretically at least, be made without any knowledge of the configuration of the system at any given time or times, beyond a general idea of the order of magnitude of certain of the constants involved. The third and final stage consists in a determination by observation of the various constants which have entered into the theory and the substitution of their values, so as to obtain numerical expressions for the co-ordinates in terms of the time."

It is the completion of the first of these stages which has primarily been the object of Professor BROWN's past labors; and as a result he has, after arduous work extending over the past fifteen years, completed the solution of the problem of three bodies for the case of Sun-Earth-Moon with an accuracy very far in excess of that attained by any of his predecessors in this line of research.

Dr. G. W. HILL, who speaks with the highest authority, has expressed the following opinion on Professor BROWN's work:—

"Much as we rightly welcome the results of Professor BROWN's devoted labors, we should be unwarranted in assuming that their employment in the lunar tables would give rise to a marked improvement in the representation of observations. A slight one indeed might be expected; but it has been evident for some time that the Moon deviated from its calculated orbit more because it is subject to irregular forces, which we have not yet the means of estimating, than because the tables are affected by slight defects in the mathematical treatment of the forces which are already recognized. This circumstance in no sense diminishes the credit due to Professor BROWN's work."

By giving accurate values to the known perturbations, Professor BROWN has defined more clearly the further irregularities of which the explanation has yet to be ascertained.

The precautions taken by the medalist to secure accuracy in the final results have been most refined. In accordance with the original programme, every coefficient in longitude, latitude, and parallax which is so great as one hundredth of a second of arc, has been computed, and is regarded as accurate to at least this amount, the results being obtained to one thousandth of a second. To avoid the occurrence of errors of computation, equations of verification have been computed at every step of the work, every page of the manuscript having, on the average, not less than two test equations computed. The medalist is the first lunar theorist to use independent equations of verification, thus creating a higher degree of confidence in his results than could ever come from mere duplicate calculation.

In devising the details of his research, the medalist arranged the work so that considerable proportions could be done by computers; but as a matter of fact only one—Mr. IRA L. STERNER, of Haverford College, of whose ability and accuracy Professor BROWN speaks in the highest terms—has been employed. "The calculations have probably occupied altogether eight or nine thousand hours. There were about 13,000 multiplications of series made, containing some 400,000 separate products; the whole of the work required the writing of between some four or five millions of digits and *plus* and *minus* signs."

Professor BROWN has completed his solution of the problem of three bodies for the case of the Sun-Earth-Moon by methods involving striking elegance and originality, and showing great powers of resource. He has, however, by no means

finished his labors. As he himself has pointed out, in announcing the completion of the main problem, much still remained to be done before it was advisable to proceed to the construction of tables. On this work he is now engaged, and we may rest assured that he will continue to bring to bear upon it that energy and power of organized inquiry which have enabled him already to secure such brilliant results.

Professor BROWN is an Englishman who has long been resident in America, and who has for the past sixteen years been connected with Haverford College. That association will, however, be broken in the ensuing summer, and next autumn Professor BROWN proceeds to Yale University. It is exceedingly gratifying to know that his work on the lunar theory, which he has been able to carry on at Haverford under most favorable conditions, will not be interrupted by this change. The Yale authorities have recognized the importance of his work by arranging special facilities for its continuance, and have also most generously undertaken to provide the funds required for both the preparation and publication of the lunar tables which will form the natural outcome of Professor BROWN'S labors. A. O. L.

Volume I, number I, of the *Journal of the Royal Astronomical Society of Canada* bears the date January-February, 1907. The object of the society is, in the words of the editor, "to extend and popularize the study of astronomy, astrophysics, and related branches of science." The pages of the journal are to be open to accounts of the work of amateurs as well as to technical papers. For the present the publication is to appear bi-monthly. The editors hope, however, soon to be able to issue it monthly.

Among the papers of especial interest in this first number may be mentioned the president's address, on "Progress in Astronomy and Astrophysics during 1906," and an article by J. S. PLASKETT, on "The Spectrum of *Mira Ceti*." The "Notes from the Dominion Observatory," "Brief Astronomical Reviews," and "Astronomical News" are also worthy of mention as interesting and valuable features.

Notes from "Science."—A bill has been introduced in the legislature incorporating the New York Observatory and Nau-

tical Museum, to which reference has already been made in *Science*. It is stated in the charter that this museum is "for the purpose of encouraging and developing the maritime interests of New York City, of advancing the general knowledge of the safe navigation of the sea, of the development of harbor facilities, of prosecuting original researches in astronomy and navigation and in kindred subjects, and of affording instruction in the same."

Substantially, the museum would be placed on the same basis as the Museum of Natural History and the Metropolitan Museum of Art. The city is to provide the land and is to erect the buildings, while the corporation is to secure by private subscription not less than $300,000 for equipping the nautical museum and observatory and for prosecuting the other objects of the institution.

The French Government has made Professor SIMON NEWCOMB, U. S. N., (retired), Commander of the Legion of Honor.

Mr. E. B. MCCLELLAN, third assistant at the Radcliffe Observatory, Oxford, died on January 2d, at the age of forty-five years.

Mr. H. F. NEWALL, of Trinity College, Cambridge, assistant director of the observatory, has been elected president of the Royal Astronomical Society, in succession to Mr. W. H. MAW.

Planet Markings.—At the 628th meeting of the Philosophical Society of Washington, held on February 2d, Professor NEWCOMB read a paper on "The Optical and Psychological Principles Involved in the Interpretation of the Markings on the Disks of the Planets." A short outline of the paper may be found in *Science* for March 1, 1907.

Mr. JAMES D. MADDRILL, of the University of California, Fellow in the Lick Observatory, who will take the examinations for the degree of Doctor of Philosophy in Astronomy, Physics, and Mathematics in May, has been appointed by the Superintendent of the United States Coast and Geodetic Survey to succeed Dr. SIDNEY D. TOWNLEY as observer at the International Latitude Observatory in Ukiah, and will enter upon his duties in July. A. O. L.

Obituary.—The *Astronomische Nachrichten,* No. 4145, contains a notice concerning the life and works of JEAN ABRAHAM CHRÉTIEN OUDEMANS, who died on December 14, 1906, at the age of seventy-nine years. OUDEMANS was for many years Professor of Astronomy and Director of the Observatory at the University of Utrecht. He was chiefly interested in the practical side of astronomy, and as an observer and computer held high rank among his contemporaries. He was also interested in geodetic work, and spent eighteen years in charge of the triangulation of the Dutch East Indies. The result of this work was published in six volumes under the title of "Triangulation of Java." Although Professor OUDEMANS retired from the directorship of the Utrecht Observatory in 1898, yet he did not give up his astronomical work, and only a short time before his death presented a paper at a meeting of the Royal Academy of Sciences of Amsterdam, on the "Mutual Occultations and Eclipses of the Satellites of *Jupiter* in 1908," an abstract of which will be found in these notes in our next number.

Miss AGNES MARY CLERKE, the scientific writer, died on Sunday morning, January 20th, at her residence, 68 Redcliffe Square, S. W., London, England, at the age of sixty-four. An astronomical correspondent writes with reference to Miss CLERKE:—

"During the last century two ladies only were elected honorary members of the Royal Astronomical Society—CAROLINE HERSCHEL and Mrs. SOMERVILLE. The new century soon saw fresh honorary members elected, and among them Miss AGNES CLERKE, whose last important work, 'Problems in Astrophysics,' was of such great scientific value that the Astronomical Society could no longer ignore her claims to public recognition by them. And when we say 'last important work' we must acknowledge also the outstanding merit of two earlier books, 'The System of the Stars' and 'History of Astronomy in the Nineteenth Century,' besides less important volumes, 'The HERSCHELS and Modern Astronomy,' 'Modern Cosmogonies,' and many scientific magazine articles, principally of the nature of reviews or interpretations of results, in which her keen insight into the true significance of observed physical facts was as wonderful as her fluency and command of language, so that both from the literary and scientific standpoints she must be ranked as a great scientific writer. No one writing a history of modern astronomy can fail to acknowledge the great debt owed to the masterly array of facts in her 'History.' No worker in the vast field of modern sidereal astronomy opened by the genius of HERSCHEL and greatly widened by the application of the spectroscope

to the chemical and physical problems of the universe lacked due recognition by Miss CLERKE, who performed as it seemed no other writer could have done the work of collation and interpretation of this enormous mass of new material, ever pointing the way to new fields of investigation, often by one pregnant suggestion sweeping aside a whole sheaf of tentative conjectures and indicating, if not the true line—for in many cases the truth is yet to seek—at least, a plausible and scientific line well worth pursuing. She will be missed at the meetings of the Royal Astronomical Society, at which she was a constant visitor even before her election as an honorary member, and where her clear judgment was at times called upon to determine the value of some new suggestion in the domain of celestial physics. She was not a practical astronomer in the ordinary sense; but her death, on Sunday morning, leaves a gap that will be hard to fill. She was the daughter of Mr. JOHN WILLIAM CLERKE, who died in London in 1890. Her sister, Miss C. M. CLERKE, who died a few months ago, also wrote on astronomical subjects, though in a far more humble way."—*The Times, London.*